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ABSTRACT

This paper discusses whether thinking skills can be taught. The concept of teaching thinking goes back to the ancient Greeks. The notion of inborn intelligence was dominant until the 1960s but was challenged by the constructivism theory developed by Vygotsky. The discussion is divided into 5 sections: (1) describing thinking and intelligence; (2) main approaches used by teachers to teach thinking; (3) evaluation of previous publications from the United Kingdom and the United States; (4) conclusions drawn from previous studies; and (5) recommendations for the future. (Contains 24 references.) (YDS)

Appendix 3: Starter Paper

Can Thinking Skills be Taught?

A paper for discussion

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Contents

	page
1. Introduction	28
2. The question: 'Can thinking skills be taught?'	29
2.1 Background to the question	29
2.2 What does science tell us about thinking?	29
2.3 What are thinking skills?	31
2.4 Why are thinking skills considered to be important?	32
2.5 The question redefined	32
3. What approaches have teachers taken?	33
3.1 Specifically designed programmes	33
3.2 Embedded/infused in the curriculum	34
4. What does the research evidence tell us?	35
4.1 Specific programmes	35
4.2 Infusion method	37
4.3 Infused across the curriculum	37
5. What conclusions can we draw?	38
5.1 The 'mind'	38
5.2 A possible framework	38
5.3 Two or three approaches?	38
5.4 Outcomes	39
5.5 What is achievable?	39
5.6 Information and communications technology	39
6. Where do we go from here?	39
6.1 Methods	39
6.2 Curriculum	40
6.3 Stages	40
6.4 Information and communications technology	40
6.5 Teaching materials	40
6.6 Teacher support	40
7. Selected bibliography	40
Endnotes	42

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1. Introduction

The workings of one mind are not witnessable by other observers; its career is private.
(Ryle, 1962, p.11)

In 1997, world authorities on intelligence including Feuerstein, Gardner and de Bono, met in Singapore for the Seventh International Conference on Thinking. As MacBeath (TESS, 20/6/97) reported all were quick to admit to 'being only on the edge of understanding the inner magic of the thinking brain'. Exactly how to portray the human mind has preoccupied philosophers for centuries and more recently psychologists, educationalists and physiologists have contributed to the debate. Ryle (1962), quoted above, points to the inadequacies of earlier attempts to separate mind from body, especially the metaphors of outer and inner worlds. With the advent of information and communications technology, the brain has been compared to a computer which processes information in a logical, consistent and systematic way, but this analogy also is rejected by some educationalists. For example, Sylvester (quoted in MacBeath, 1997) prefers the metaphor of the brain as a jungle and argues that the learning environment of the classroom should mirror this by inviting challenge and discovery across different domains.

This, then, is the overarching context for this discussion paper:

- a long history of interest in the workings of the mind by members of disparate disciplines
- a dissatisfaction with the concept of intelligence as one stable measurable quality (Gardner, 1993)
- the possibility now with the development of magnetic resonance imaging of observing the brain 'at work'
- renewed interest in the ways in which children think; and
- the belief that educationalists can improve children's thinking with specific interventions.

This paper is presented as a series of questions for discussion in seven sections, of which this Introduction is the first.

In **Section 2**, the question for discussion is redefined and located within the context of theories of mind and how thinking and intelligence are portrayed.

Section 3 outlines the main approaches by which teachers have tried to teach thinking.

Section 4 presents the available evidence from published evaluations in both the UK and USA.

In **Section 5**, I indicate the conclusions which I think can be drawn from previous studies.

And **Section 6** addresses the question: 'Where do we go from here?'

Finally in **Section 7** information on the databases searched is presented with readily available sources identified and the **End Notes** provide a short glossary.

2. The question: 'Can thinking skills be taught?'

2.1 Background to the question

As Nisbet notes (1990) the concept of teaching thinking is not new. From the ancient Greeks onwards improving the intellect was perceived to be a prime aim of education. For Plato this entailed engaging in the Socratic dialogue and traditional logic. Some European countries, for example France, have traditionally included philosophy in the school curriculum. Others have argued that the teaching of Greek and Latin, to which mathematics and formal logic were added in the twentieth century, provide a training in rational thinking. In addition, the notion of inborn intelligence which dominated educational practice until the 1960s (Nisbet, 1990) was challenged by Vygotsky (1962) and others who developed a constructivist psychology predicated on learners as active creators of their own knowledge. By the end of the twentieth century this found expression in the development of 'core' or 'key' skills, such as problem-solving and decision-making, which some suggest can be embedded in primary and secondary school curricula.

2.2 What does science tell us about thinking?

It is impossible to summarise the findings from a number of disciplines within the constraints of this short paper: here I highlight a few significant points. Clearly, physiology (the science concerned with the functioning of human organs), psychology (the development of theories of mind and intelligence) and epistemology (the branch of philosophy which focuses on theories of knowledge), all impact on cognition/thinking. In particular cognitive psychology and epistemology have done much to clarify our understanding of the term 'thinking' and dispositions, such as attention and motivation, commonly associated with thinking. What then are the significant issues for teachers?

First, from biological psychology (Groves & Rebec, 1992) supported by psychiatry, neuroscience and pharmacology, a picture emerges of the brain and the processes associated with thinking. For the past 150 years scientists have attempted to localise functions within the human brain. To many scientists 'the brain with its unappealing wrinkles and bland, gray color, hardly seemed alive' (p.4). Gradually through clinical cases and laboratory experiments, evidence emerged that certain functions were located in specific area, for example speech in Broca's area; while areas of the cerebrum, which occupies most of the top and front of the brain, are probably linked with less specific 'higher mental activity'. A break through came in 1921 when a neuroanatomist described how although the nerve cells in the brain are packed close together, there is no physical connection between them.

Techniques, such as positron emission tomography (PET scans) allowed scientists to monitor the blood flow to various parts of the cerebral cortex while subjects performed different semantic tasks, such as hearing, seeing and speaking words. From these developments we can conclude that:

- Despite advances in knowledge, there is still much to learn about the working brain: in recognition of this fact the 1990s were designated the Decade of the Brain in the USA.
- Most of the growth in the human brain occurs in early childhood: by the age of six, the brain in most children is approximately 90% of its adult size. This implies that intervention, while the brain is still growing, may be more effective than waiting until the brain is fully developed.
- Although specific areas of the brain are associated with particular functions, large parts of the cerebrum – (commonly referred to as the 'thinking cap') appear to have a more general function. Some suggest that it functions in a similar way to extra memory in a computer and is brought into play to work more generally on higher level activities.
- There appears to be a two-way relationship between the working of the cerebrum and the tasks upon which it is engaged: while the connections within it are necessary for higher level activities to be undertaken, those connections also develop if stimulated.

Second, psychological theories provide a link between the physiology of the brain (described above) and thinking; here too developments have occurred. The first half of the twentieth century was dominated by a belief in innate general intelligence which was thought to be fixed and measurable. However, this interpretation has been discredited on two fronts: first, because IQ may not be stable over time (the Flynn Effect); and second, intelligence is thought to be more than a set of inherited abilities.

Continuing developments in cognitive psychology in the second half of the twentieth century have generated alternative explanations. Many teachers will have been trained in Colleges of Education heavily influenced by the work of Swiss psychologist Jean Piaget, who deduced his theories from detailed observation and children's play. Put simply, Piaget claimed that all children pass through certain well-differentiated stages in their thinking and they do so in the same sequence no matter where they live. Each stage is characterised by particular behaviours and types of cognitive functioning (Siann & Ugwuegbu, 1988) and educational interventions should be appropriate to staged development.

Other constructivists stressed the active role of the learner in developing their own thinking. Bruner linked reasoning to the structuring of experiences, the development of schemata (by which learners give meaning to their experiences)

and concept formation closely associated with language acquisition. Vygotsky (1962) stressed the cultural aspects of learning through active participation in collaboration with others while appropriately supported by the teacher (scaffolding). The differences are, as LaFrancois (1999) points out that 'Piaget sees development as a sort of unfolding guided by internal tendencies: Vygotsky sees development as a result of the child's interaction with other people (p.103).

Continuing this attack on the concept of a fixed general intelligence, Gardner (1983) made the case for at least seven (perhaps ten) different intelligences. His theory of multiple intelligence describes competencies in logical-mathematical, linguistic, musical, spatial, kinesthetic, interpersonal and intrapersonal domains. How these can be assessed remains problematic.

All of these developments have implications for teaching thinking skills. Some of which are:

- Brains are portrayed as under-used and, therefore, capable of further development by stimulation.
- Learning is seen as requiring active participation by learners who learn best in a social environment in which they give meaning to their own experiences.
- To build the necessary conceptual schemata, learners must be supported by teachers (Vygotsky's scaffolding) who gradually extend the learning challenges and provide appropriate feedback.

To summarise, cognitive psychology is concerned with the processes involved in thinking (ie knowing, remembering, perceiving, attending etc). The cognitive processing view of intelligence is, as LaFrancois (1999) suggests, a little like a box of tools that we use to play the game of cognition: we may not all have the same tools in our kit, but we can certainly improve how we use them. If cognition (thinking) is to be improved, then it is argued that teachers must make the learners' thinking processes *explicit* by employing methods which intervene directly on the 'thinking processes'. Part of this involves making learners aware of themselves as thinkers and how they process/create knowledge by 'learning how to learn' (metacognition). It is to these skills that we now turn.

2.3 What are thinking skills?

'Thinking skills' is an ambiguous term. Some argue that mental processes cannot accurately be described as skills in the same way one would describe a motor skill. There is also no consensus as to what should be included in the category of 'thinking skills'. Most writers assume that the term includes 'higher level' activities such as problem solving, decision making, critical thinking, logical reasoning and creative thinking (Nickerson, 1988). McGuinness (1999) points out that different researchers have produced different taxonomies of thinking. Most include some or all of the following:

- collecting information
- sorting information
- analysing information
- drawing conclusions from the information
- 'brainstorming' new ideas
- problem solving
- determining cause and effect
- evaluating options
- planning and setting goals
- monitoring progress
- decision making
- reflecting on one's own progress.

All are based upon the assumption that thinking (cognition) goes beyond the acquisition of knowledge (ie Ryle's, 1962, 'knowing that') and include the process(es) of knowing about thinking (metacognition) ie being able to reflect on the processes by which learners process information.

2.4 Why are thinking skills considered to be important?

Most countries are currently concerned with raising educational standards throughout the compulsory school years. But it is also argued, as the OECD (Maclure & Davies, 1987) points out, that the minimal requirements of schooling, ie mastery of the 'basics' (reading, writing, mathematics, science etc.), however excellently taught, are not sufficient to meet the demands of the labour market and active citizenship. It is now recognised that a broader range of competencies, redefined as 'higher order' thinking skills, is required because:

- The 'banking theory' of knowledge based upon rote learning has been discredited as it is recognised that individuals cannot 'store' sufficient knowledge in their memories for future use.
- Information is expanding at such a rate that individuals require transferable skills to allow them to address different problems in different contexts at different times throughout their lives.
- The complexity of modern jobs requires staff who demonstrate comprehension and judgement as participants in the generation of new knowledge or processes.
- Modern society assumes active citizenship which requires individuals to assimilate information from multiple sources, determine its veracity and make judgements.

Collectively, these present, as Resnick (1987) argues, 'a new challenge to develop

educational programmes that assume that all individuals, not just an elite, can become competent thinkers' (p.7) because these competencies are now required of all. The cognitive approach suggests that learners must develop an awareness of themselves as thinkers and learners and practise the approaches and strategies for effective thinking.

2.5 The question redefined

In the light of this background, can thinking skills be taught? At one level, the question is far too general to be answered. As Ryle (1962) notes all human beings, except those who have sustained specific injury or suffer from certain disabilities, demonstrate that they can think. It is, therefore, more helpful for this discussion if we redefine the question as: 'Can children be taught to think more effectively?' Accelerating cognition is a more meaningful and manageable topic for discussion. The aim of this paper is, therefore, to provide a 'starter' on this topic for discussion by an Education Forum of teachers and others. It seeks to:

- clarify the essential terms for discussion
- identify ways in which teachers have attempted to improve children's thinking
- summarise the main findings from evaluations of teaching thinking skills; and
- indicate areas for future work.

3. What approaches have teachers taken?

In this section we consider the approaches which teachers have used to improve children's thinking. Nisbet (1990) identifies two main approaches: one through specifically designed *programmes* and the other by *infusion* throughout the curriculum. McGuinness (1999), while agreeing with this general distinction between programmes and infusion, subdivides the latter. She points out that thinking skills can either be embedded in particular subjects eg in science, mathematics, history and geography, or more generally across the whole curriculum.

3.1 Specifically designed programmes

In 1990 Nisbet and Davies identified over 30 programmes of instruction on thinking skills but went on to suggest that there were in fact over a hundred in the USA alone.

3.1.1 Feuerstein's Instrumental Enrichment

The best known example of a thinking skills programme is Feuerstein's Instrumental Enrichment (IE) (Feuerstein, 1980) developed over 40 years ago for use with low-performing Israeli adolescents. It is a context-free cognitive intervention programme based upon the concept of 'mediated learning'. An adult shows a learner specific methods for interpreting information and problem-solving. These become progressively more demanding through 14 instruments used over

2-3 years and introduce such concepts as syllogisms, favoured by the ancient Greeks.

3.1.2 *Cognitive Research Trust (CoRT) – de Bono*

Edward de Bono has written over fifty-six books on teaching thinking. His approach, especially such tools as 'thinking hats', are used in some schools and his programme developed through the Cognitive Research Trust is now accessible to schools. It consists of six sections, each of ten lessons including a teacher's handbook and lesson notes for pupils. Each section covers one aspect of de Bono's definition of thinking: breadth, organisation, interaction, creativity, information and feeling, and action. The lessons encourage learners to stop in the middle of a lesson and consider the views of other people involved in the situation. Its overall aim is to translate thinking which, he claims, is 'a pretty nebulous subject and needs anchoring with some focus of attention' (de Bono, 1991, p.187) by use of structured exercises.

3.1.3 *The Somerset Thinking Skills Course*

The Somerset Thinking Skills Course (Blagg *et al*, 1988) is a general thinking skills course. It consists of a handbook and several modules including the foundations of problem-solving, analysing and synthesising, propositions in space and time, predicting and deciding etc. The exercises may be used as a free-standing programme or integrated across the curriculum, usually in the upper primary school or with mixed ability groups in secondary schools. Unlike the Instrumental Enrichment Programme which presents abstract concepts, the Somerset course is pictorial and naturalistic.

3.1.4 *Cognitive Acceleration through Science Education (CASE)*

Cognitive Acceleration through Science Education (CASE), although set within the context of science, is a structured programme rather than an infused method. The programme consists of instructional materials for teachers, which present the concepts associated with formal operational thinking, and curriculum materials for use with pupils aged 11+ to 13+. Unlike philosophy, which makes use of deductive reasoning ie arguing from the given to the specific, CASE is based upon inductive reasoning. It encourages children to move from concrete examples to abstract generalisations, noting dissonance and promoting 'bridging' across other subject areas.

3.1.5 *Philosophy for Children*

Philosophy for Children is a network whose approach is associated with Lipman (1980) and has been further developed in the UK by Fisher (1995, 1998). Lipman believed that children were 'natural philosophers', constantly asking questions, considering alternatives and seeking answers. Teachers should exploit dialogue, using a Socratic framework, by modelling dialogue and structuring classroom

activities in ways that promote its development. A number of novels, demonstrating children as problem-solvers, are recommended. Fisher has developed this approach further by focusing on questioning within classrooms, the ways in which teachers manage the process and develop a 'community of enquiry'.

3.2 Embedded/infused in the curriculum

As we identified earlier, thinking skills can be embedded/infused within specific subjects or across the curriculum more generally. Examples include:

3.2.1 Mathematics

Mathematics has long been associated with logical thinking (eg Russell and Whitehead's *Principia Mathematica* (1910). The teaching of mathematics in schools has also developed. McGuinness (1999) points out that the trend is now to focus on the skills required to solve mathematical problems rather than the answers, *per se*, and to encourage 'situated learning' ie the use of maths in a real context.

3.2.2 History

The teaching of history has changed dramatically since the 1960s and represents a major shift away from teaching 'historical facts' to broad themes and understanding. Earlier work in England by the Schools' Council's History 13-16 Project, in which students were introduced to the concepts of historical evidence, sources and interpretation, focused on the nature of historical enquiry rather than the facts, *per se*. Curriculum and assessment of the subject in Scottish schools reflect these major changes. Therefore, thinking skills, ie collecting evidence, problem-solving, analysis and interpretation, should by now be well-embedded in the way teachers approach this subject area.

3.2.3 Thinking through Geography

This programme designed by David Leat of the University of Newcastle in partnership with geography teachers (Leat, 1998) identifies a list of 'big concepts' which the authors claim are necessary for an understanding of geography. These include: cause and effect, classification, planning, decision-making, location, inequality, development, systems. Twenty-four exemplar lessons were developed, each of which targets a concept. The lessons encourage concept development, the development of children's vocabulary for talking about thinking and the use of talk and group work for generating and evaluating alternative solutions. Teaching for transference is built into the programme.

3.2.4 Activating Children's Thinking Skills (ACTS) (McGuinness *et al*, 1997).

This project aimed to promote the development of thinking skills in ordinary classrooms in Northern Ireland at Key Stage 2. A Handbook was developed by McGuinness and a small group of teachers using a strategy similar to the one

adopted by Leat (1998). Thinking diagrams or 'graphic organisers', eg for decision-making, were produced as an aid to making the steps in thinking explicit to learners.

4. What does the research evidence tell us?

In Section 3 above, I outlined some of the better-known examples of programmes and approaches to teaching thinking. I now consider published evidence from evaluations of these programmes.

4.1 Specific programmes

4.1.1 Instrumental enrichment

The evidence here is contradictory. Savell *et al* (1986) in a review of evaluations conclude that statistically significant differences had been reported between IE trained groups and control groups in four different countries (Israel, USA, Canada and Venezuela) in middle and lower social class groups and in both mixed ability and educationally disadvantaged groups. Increases in non-verbal reasoning were reported but other effects, such as self-esteem, improved classroom behaviour, attainment tests, were inconsistent.

In contrast, Blagg (1991) in a two-year evaluation of IE intervention with 14 year-old low-achieving adolescents in four schools in Somerset reported no significant improvements in intelligence tests or tests of reading and mathematics in the experimental groups compared with the control groups. Cultural differences may explain some of the findings, but Blagg attributes them to the 'abstract' nature of the programme. This dissatisfaction led him to develop the Somerset Thinking Skills Course.

4.1.2 Cognitive Research Trust (CoRT)

De Bono (1991) discusses in detail the problems inherent in testing 'thinking' and, hence, in proving the efficacy of thinking skills programmes. It is now well-recognised that forms of assessment, which are presented as objective, may inadvertently be culturally biased. De Bono argues for teachers' assessment and presents evidence from a sample of small-scale experiments reporting 'idea-counting'. For example from tape recorded discussions of four CoRT trained primary school classes of children aged 10 to 11 and four control groups, he claims that much 'wider' ideas emerged from the CoRT groups.

4.1.3 The Somerset Thinking Skills Course

McGuinness (1999) reports that no large-scale evaluation of the effects of this course on subsequent intellectual performance is available (p.11). However, 14 controlled studies of the former Department of Employment funded *Thinking Skills at Work* programme, which was based upon the Somerset Course, were conducted by Blagg *et al*, 1993). They report that in 12 of the 14 studies significant benefits

eg ability to recognise complex problems, plan and review work and demonstrate greater self-confidence for both trainees and trainers, were identified.

4.1.4 *Cognitive Development through Science Education (CASE)*

As most commentators note, longitudinal studies of the efficacy of teaching thinking are significantly absent. An exception is Adey and Shyer's (1993) two-year evaluation of CASE from 12 classes (four of 11-year-olds and eight of 12-year-olds) each of which was matched with a control class. Pupils were tested immediately after the programme and again one year later. Their subsequent GCSE results in Science, English and Mathematics were compared. It is claimed that CASE pupils' grades in GCSE Science were on average 1 grade above the control groups; smaller gains were recorded for Mathematics and English.

4.1.5 *Philosophy for children*

There is some evidence here from both the USA and the UK. Lipman (1980) reports the results of an evaluation conducted in the late 1970s by the Educational Testing Service of Princeton, New Jersey of 200 students, aged 10–13 years. Students in two locations participated in the programme for two years. The results indicate improvements in intellectual performance, especially in reading and mathematics and also on creativity measures within the experimental group. In the UK, Fisher (1995) points out the difficulties in evaluating *Philosophy for Children* programmes because of its wide-ranging goals and the absence of appropriate evaluative dimensions on standardised tests. He suggests that gains are related to the quality of ideas generated, the skills of discussion and analysis and self-esteem – all of which are more difficult to measure on normative scales.

4.2 **Infusion method**

Evaluations of thinking skills embedded into subjects or across the curriculum are less well-documented. McGuinness (1999) suggests that small-scale teaching experiments are beginning to find their way into the literature: these are not necessarily accompanied by objective evaluations.

4.2.1 *Mathematics*

Schonenfield (1992, in McGuinness, 1999) reports findings from his programme for teaching mathematics to college students in which he models problem-solving through analysis, exploration and verification. He claims that a 'before and after' comparison of the problem-solving skills of students who attended his own courses compared with those students attending other courses indicate a marked difference. His students performed better not only on problems which he had covered during his course but also on different problems.

4.2.2 *History*

Results in this subject are again mixed. Peel (1967) suggests that pupils who had

worked through the School's Council's History Project achieved higher levels of understanding of the nature of historical enquiry. In contrast, Wineburgh (1996) concludes that: 'the key way stations, the cognitive bridges, along the path to higher understanding' (p.429) followed by teachers and students on the History Project were not clarified.

4.2.3 Geography

No formal evaluation of this programme is reported.

4.3 Infused across the curriculum

4.3.1 Activating Children's Thinking Skills (ACTS)

McGuinness, who developed this programme with teachers in Northern Ireland, reports teachers' evaluation of the impact of ACTS on pupils and themselves. Overall their feedback is positive and teachers were very satisfied with the methodology. All teachers reported benefits in children's thinking, reasoning powers and creativity and in their own concepts of thinking, review of schemes of work and effective planning. However, as McGuinness points out there are limitations to an evaluation of this type because it relies on teachers' perceptions which were unrelated to learning outcomes in the classrooms.

5. What conclusions can we draw?

What conclusions can we draw from these projects discussed in Section 4 above.

5.1 The 'mind'

The 'rediscovery of the concept of mind', an interest in cognitive psychology linked with attempts to analyse the processes involved in acquiring the skills of learning, and a dissatisfaction with the concept of one measurable form of intelligence provide the overarching context for teaching thinking skills. An 'active' theory of 'learning how' rather than 'learning that' provides the theoretical basis (see Ryle, 1962).

5.2 A possible framework

Some suggest that there is now sufficient research and practical experience to form a framework for developing thinking skills. McGuinness (1999) proposes that a general framework for teaching thinking should include:

- the need to make thinking skills explicit in the curriculum
- adopt a coaching style to teach thinking
- operate within a metacognitive perspective
- develop collaborative learning in both face-to-face and computer-mediated learning
- encourage good thinking habits or general dispositions

- generalise the framework beyond a narrow focus on special skills to encompass the whole curriculum and concepts of 'thinking classrooms' and 'thinking schools'.

Others (Nisbet, 1990; Entwistle, 1987) prefer a hierarchical model, arguing that schools should teach both specific skills and also strategies:

- *Specific Skills* – skills specific to subjects or general skills specific to tasks shared in related subjects
- *Learning Strategies* – generalised procedures or sequences
- *Approaches to learning* – self-regulated learning.

5.3 Two or three approaches?

Researchers are divided on the number of approaches to teaching thinking skills: Nisbet suggests two, while McGuinness proposes three. All, however, distinguish between *specific programmes* on the one hand, and an approach which is *embedded* in either subjects or across the curriculum on the other. Transference beyond the specific context remains problematic.

5.4 Outcomes

Evaluation studies are inconclusive. A number purport to link successful outcomes with teaching thinking skills but it is difficult to control for the influence of other variables. McGuinness (1999) points out that the most successful interventions are associated with a 'strong theoretical underpinning, well-designed and contextualised materials, explicit pedagogy and teacher support' (p.1). However, 'scaling-up' and generalising from findings emerging from small evaluation studies have still to be overcome. Problems of mediation, transference and bridging remain.

5.5 What is achievable?

Most research has been conducted under optimal learning conditions. Problems of embedding the approach into everyday classroom practice, based upon what the average teacher can achieve rather than the expert practitioner working in good conditions with well-motivated pupils, remains to be demonstrated. Therefore, teacher development opportunities and support are required if classroom practices are to change.

5.6 Information and communications technology

Information and communication technologies provide logical frameworks which some argue will enhance children's thinking, either through individual interactions with computers and multimedia or opportunities for collaborative learning through networks. More evidence on computer/learner interaction and collaborative learning is still required.

Finally, there appears to have been a general shift from discussing 'thinking children', through 'thinking classrooms' to 'thinking schools'. These may be realisable aims for an education system, or alternatively, simply more metaphors for teachers to decode and translate into practice. McGuinness (1999), while accepting the limitations of available evidence, comes down strongly on the side of the value of teaching thinking skills. My own conclusions are more cautious. Given the paucity of evidence, it would, perhaps, be fairer to conclude that 'the jury is still out' on this particular issue.

6. Where do we go from here?

As Nisbet (1984) points out, encouraging metacognition (see end notes), accelerated learning or thinking skills is still an unfinished story. Fundamental research on the nature of intelligence and its stability over time will continue (see Appendix 4 for a report on the SCORE data by Deary *et al*, in press). There are, however, a series of further issues on which teachers could profitably reflect, bringing both their professional expertise and practical understanding. These include:

6.1 Methods

Which is the most effective method for improving children's thinking skills: the use of *special programmes*, an *infusion approach* within either individual subjects or across the curriculum or a combination of both? Both have drawbacks and further evidence of outcomes, especially from 'scaled-up' examples, is required.

6.2 Curriculum

Can a curriculum, with core thinking/problem-solving skills be constructed without overloading both teachers and learners? Evidence from the Wales Curriculum 2000 (Wilson *et al*, 1999) indicate that teachers believe it is easier to embed 'core skills' within certain areas than in others, eg within the primary curriculum and history as opposed to modern languages in the secondary school curriculum. What is the experience of teachers in Scottish schools?

6.3 Stages

Which are the most appropriate stages for teachers to introduce metacognitive development: pre-school, primary, secondary, further, higher or adult continuing? So far adult continuing with its reliance on 'andragogy' as a theory of learning, has led the way. Are there lessons to be learnt here?

6.4 Information and communications technology

The use of new technology within schools offers the possibility to develop accelerated thinking. As yet we know little about computer/child interaction or the mediating role of the teacher. This is an area where the Economic and Social

Research Council's (ESRC) programme on Teaching and Learning should yield further evidence.

6.5 Teaching materials

Are there sufficient high quality teaching/learning materials for use in Scottish schools? Currently SCCC is developing materials for core skills for Higher Still. Do materials need to be developed which articulate with 5-14 and Standard Grade or can interested teachers adapt materials from elsewhere?

6.6 Teacher support

If teachers are to be encouraged to develop children's thinking skills explicitly, what support do they require? Is this topic more appropriately located within initial training or at post-experience levels? Are other forms of support required?

7. Selected bibliography

This bibliography is selective. Three databases were searched: ERSDAT, the British Education Index and ERIC. Key words *teaching thinking*, *teaching philosophy*, *teaching cognition* and *metacognition* were used. Only 2 items were identified in ERSDAT. The British Education Index from 1976-99 yielded 14 references for *teaching thinking*; 1 each for *teaching philosophy* and *teaching cognition*, and 119 for *metacognition*. ERIC over a shorter period, 1983-99, provided 97 references for *teaching thinking*, 98 for *teaching philosophy* and 2,274 for *metacognition*. An additional search using *brain* as a keyword was conducted. Only 33 references were identified in the British Educational Index, the latest dated 1996, and 2,260 from ERIC, most on brain damage. Most references are American and few comply with Slavin's (1984) conventions of best evidence: many are resource books and manuals for practitioners' use rather than evaluations. A selected bibliography of sources is listed below:

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End notes

- 1 **Constructivists** is a general label for psychologists who claim that meaningful knowledge and information are constructed by the learner, and hence, teaching and learning should be highly learner-centred. This is often contrasted with direct instruction as a method of teaching and learning.
- 2 **Cognition** is the process by which humans acquire knowledge. It includes thinking, perceiving, attending and understanding.
- 3 **Intelligence Quotient (IQ)** is a way of measuring general ability by multiplying the ratio of a child's mental to chronological age by 100 and comparing the score to comparable groups of people. The Stanford-Binet tests are the best known examples of measures of intelligence for verbal reasoning, quantitative reasoning, abstract/visual reasoning and short-term memory: collectively they provide a composite score which is generally interpreted as an IQ score.
- 4 **Flynn Effect:** Flynn (see LeFrancois, 1999) examined IQ data from 14 countries spanning 50

- years and identified gains over time. The implications for teachers are that teaching and learning (or other factors) may be contributing to the general rise in IQs over generations.
- 5 **Scaffolding** is the term used by Vygotsky to describe various types of support that teachers or carers need to provide for children to enable them to learn. It may include verbal assistance, questioning, suggestions and directions, all aimed at extending the child's activities into an area (of proximal growth) in which the child cannot accomplish the activities alone.
 - 6 **Metacognition** is a higher level activity which is defined as knowledge about cognition/knowing. It requires learners to develop the ability to reflect on their own ways of acquiring knowledge ie learning to learn.
 - 7 **Scottish Mental Survey** data are the results of IQ type tests of every 11-year-old in school on 11 June, 1932 and 1947 (87,498 and 70,805 children respectively). They are currently being reanalysed by a multidisciplinary team from the Universities of Edinburgh and Aberdeen and SCRE, led by Professor Ian Deary. (See TES, 3/3/2000 in Appendix 4.)
 - 8 **Andragogy** is a theory of learning based upon self-direction and autonomy of the learner.
 - 9 **Economic and Social Research Council (ESRC)** is an agency which allocates Government funding for research in the social sciences throughout the UK. A current priority area is teaching and learning to which £12.5 million has been allocated. Researchers compete for research funding.
 - 10 **ERSDAT** is a database of educational research in Scotland maintained by SCRE and funded by SEED.
 - 11 **The British Education Index** is the major indexing service of educational journals in the UK.
 - 12 **ERIC** is the major US indexing service of educational articles, conference papers and reports.